

Sensor Development for Proton Exchange Membrane Fuel Cell Systems

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Subcontractors:

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Micro Substrates Corporation, Tempe, AZ

Objectives

- Establish the requirements for each physical sensor.
- Develop packaging strategies for the sensors to minimize sensor cost.
- Design and fabricate prototype sensors.
- Test sensors in third party fuel cells.

Technical Barriers

This project addresses the following technical barriers from the Fuel Cells section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year R,D&D Plan:

- B. Sensors

Approach

- Task 1. Sensor Requirements: establishes the requirements for each physical sensor and develops common packaging strategies.
- Task 2. Sensor Development: development of sensor concepts from Task 1 that culminates in sensor design engineering of prototype sensors.
- Task 3. Prototype Build & Test: fabrication and testing of the developed sensors culminating in demonstrations of the prototype sensors.
- Task 4. Field Testing: testing of prototype sensors at fuel cell and fuel processor companies.

Accomplishments

- Interviewed 10 fuel cell development companies.
- Developed customer images diagram.
- Extracted customer requirements from interviews.
- Deployed survey to 60 recipients.

Future Directions

- Finalize sensor requirements and review with DOE.
- Brainstorm the requirements for the top 2-3 solutions for each sensor.
- Prioritize solutions.
- Create Engineering Development Specification (EDS) for top priority concept for each physical sensor.
- Obtain DOE review and approval of EDS.
- Begin sensor development.

Introduction

The technical approach for this project is to look at the fuel cell system and establish the requirements for each physical sensor, then develop packaging strategies for the sensors to minimize sensor cost. Prototype sensors will be designed and fabricated at Honeywell and then the sensors will be tested in third party fuel cell systems at fuel processor companies.

Approach

In the initial phase of the project, the requirements provided by DOE in the solicitation for the individual physical sensors were investigated thoroughly and refined as needed. Honeywell interviewed fuel cell and fuel processor companies, listed in Figure 1, to attain the requirements of each customer.

A fact-based methodology, Language Analysis, that is part of a product definition process, Market Driven Product Definition (MDPD[®]), will be employed to glean fact-based information from the customer interviews. A final step in the MDPD[®] process is surveying the market with the requirements created from the interviews. A Kano Survey provides requirement validation from the broad market again through a fact-based methodology. During this development, it is Honeywell's objective to continuously re-evaluate the sensor requirements in light of new developments in the field, contracting agency inputs, and our own development status. Our goal is a continuous improvement in the sensor requirements during the initial prototype design and testing phase, leading to realistic, achievable requirements by the time final prototypes are to be developed and tested. Industry

inputs will be employed to help define packaging requirements and associated common packaging methodologies across all the sensor developments.

Results

Several customers were interviewed during the MDPD[®] process; the customer group is presented in Figure 1. The verbatim transcripts of the interviews were scrubbed to find customer images and requirements. Metrics were also pulled from the interview data during the scrubbing.

The customer images were reduced onto the customer image map shown in Figure 2. These images describe the emotion in the customer's voice. It shows that they have a problem that needs to be solved.

The customer requirements were also reduced onto a customer requirements map as shown in Figure 3. Solutions for these requirements will be

Interview List

COMPANY	INTERVIEWED	LOCATION
GM	11/13/2002	Honeoye Falls
UTC	11/20/2002	Hartford
Plug Power	11/21/2002	Albany
Avista	11/27/2002 (phone)	Spokane
Nuvera	12/11/2002	Cambridge
Ballard	01/09/2003	Burnaby
H2Fuel	01/28/2003	Chicago
Ballard	02/27/2003	Nabern
DaimlerChrysler	02/28/2003	Ulm
Ford	03/18/2003	Dearborn

Figure 1. Interview List

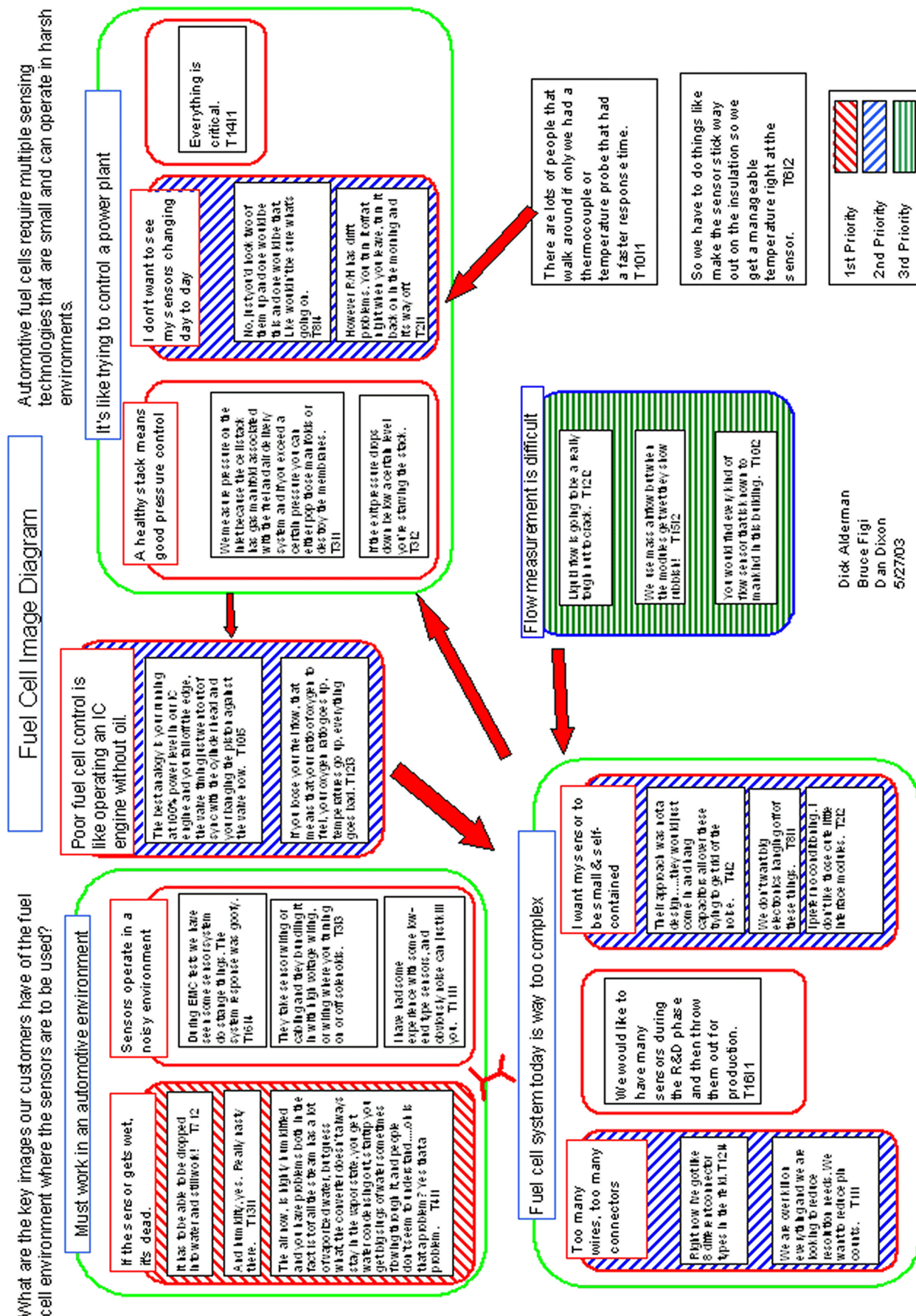


Figure 2. Customer Image Map

brainstormed by a cross functional team. The solutions will be prioritized, and engineering teams will work the concepts.

Metrics were also scrubbed from the transcripts, and those metrics were used in the customer survey to help define the bounds on the functional and environmental conditions for each physical sensor. The customer list for the survey is shown in Figure 4.

Conclusions

Many of the Task 1 conclusions will come from the survey feedback. Many of the preliminary DOE requirements for physical sensors line up with the metrics from the customer interviews.

Technical hurdles that have been identified are as follows:

- General
 - Meeting cost targets.
- Relative Humidity Sensing
 - Stability over application life.
 - Ability to provide feedback in two-phase flow.
- Flow Sensing
 - Providing a stable, accurate output in non-condensing and condensing environments.

FY 2003 Publications/Presentations

1. 2003 Merit Review - Sensor Development for PEMFC Systems, Bruce Figi, Honeywell Sensing & Controls

PEM Physical Sensor Field Survey Recipients	SENT	RECEIVED (As of 6/29/2003)
Ballard US	2	1
Ballard Gmb	2	
Avista	1	
Plug Power	2	1
Ford	2	
GM	2	
DaimlerChrysler Gmb	2	
Nuvera	2	
H2fuel	2	
UTC	3	
ANL	1	
Battelle PNL	1	
Caterpillar	2	
Cellex Power Products	1	
DeNora N.A., E-TEK Division	1	
Directed Technologies	1	
Eaton Corp	1	
FuelCell Energy	1	
Hyundai Motor Company	2	
Alternate Energy Sys Consulting	1	
Anuvu	1	
Aperion Energy Systems	1	
Arbin Instrument	1	
Asia Pacific Fuel Cell Technologies	1	
Ball Aerospace & Technologies	1	
Coleman	1	
Delphi Automotive Systems	1	
Emprise Corp	1	
FuelSell Technologies	1	
H Power	1	
H2 Economy	1	
Johnson Matthey Fuel Cells	1	
Lynntech	1	
Parker Hannifin	1	
PEI Electronics	1	
Proton Energy Systems	1	
Protonex Technology	1	1
Quantum Fuel Systems Technology	1	
Visteon	1	

Figure 4. Survey Customer List